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A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS

The present invention relates to a method and a measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material.

Such refiners are using for refining material containing fiber. The refiner generally comprises refining members in the form of discs which rotate in relation to each other and between which the material for refining passes from the inner periphery of the refining members, where the material is supplied, to the outer periphery of the refining members, through a refining gap formed between the refining members. Often one of the refining discs is fixed whereas the other rotates. The refining discs are generally constructed from segments provided with bars. The inner segments then have a coarser pattern and the outer segments a finer pattern in order to produce fine refining of the material.

To ensure high quality when refining material containing fiber, the disturbances in operating conditions that continually occur for various reasons must be corrected by constant control of the various refining parameters to optimum values. This can be achieved by altering the supply of water, for instance, so that a larger or smaller cooling effect is obtained, by changing the flow of material for refining, by adjusting the distance between the refining members, or a combination of these measures. Accurate determination of the energy transferred to the material for refining, and also of the distribution of the energy over the surface of the refining members, are necessary to enable the necessary adjustments and corrections to be performed.

To determine the energy/output transferred to the material for refining, it is already known to try to measure the shear forces appearing in the refining zone. What is known as a shear force occurs when two surfaces move in relation to each other with a viscous liquid between the surfaces. Such a shear force is also created in a refiner used for refining wood chips mixed with water. It may be imagined that the chips of wood are both sheared and rolled between the refining discs, as well as colliding with each other and the bars. The shear force is caused, inter alia, by the combined force of the discs and by the friction coefficient. The normal force exerted on the surface also varies with the radius.

Through SE-C-504801 a measuring device is already known comprising a special sensor bar, i.e. a bar provided with sensors which sense the load exerted on the sensor bar during refining, at a number of measuring points along the bar. However, the drawback of this arrangement is that measuring is only performed on occasional bars and the result is therefore unreliable. Furthermore, the type of transducer, strain gauge, used in bar experiments have a short service life since

the transducers are located close to the refining surface and the material used to screen the transducers from steam and pulp is subjected to an extremely demanding environment. However, despite these drawbacks, strain gauges must be used because of the design of this measuring device.

The object of the present invention is to solve the problems mentioned above and, first of all, to provide a method and a measuring device that produces a more reliable result than previously known devices, and also to provide a device with potential for a longer service life than previously known devices, thus making it more economical.

This object is achieved by a method as defined in claim 1 and with the characteristics specified therein, and also with a measuring device as defined in claim 4.

The method is thus characterised in that measurement of the force stress is performed across a measuring surface constituting a part of a refining disc, said measuring surface comprising at least parts of more than one bar and being resiliently mounted in relation to the surface of the refining disc. The measuring device is provided with corresponding means for performing the method. The present invention thus reveals the advantage that, in comparison with known technology, measurement of the stress force is performed over a relatively large surface, thereby producing a considerably more reliable result.

According to a preferred embodiment, measurement is performed by the measuring surface being resiliently journalled in a direction parallel with the surface of the refining disc and being movable in said direction in the event of a stress force, in relation to a rigidly mounted force sensor with which the measuring surface is connected, said force sensor thus being influenced by and measuring said stress force. The measuring device in turn reveals features comprising equivalent members.

According to a particularly preferred feature, therefore, the measuring device comprises a force sensor and a body connecting the sensor with the measuring surface. Through this arrangement the present invention achieves the advantage that the force stress is measured directly, instead of indirectly by measurement of linear strain and the like, as occurs with known technology.

The sensor, which is preferably a piezoelectric force sensor constructed of quartz crystal (a "quartz sensor") also contributes to an extremely rigid measuring device being possible. The preferred sensor will withstand temperatures of up to 200°C and is also linear up to this temperature.

In accordance with another preferred feature, the measuring surface is connected to said body and the part of said body that extends on the side of the

force sensor opposite to the measuring surface, is provided with a joint where the body is movable in a direction substantially parallel with the surface of the refining disc. However, as mentioned above, since the force sensor has a relatively stiff spring action, the shear forces will only cause extremely small movements in the joint, and thus the measuring device. This makes it easier to seal the measuring device against steam and wood chips penetrating from the surroundings, neither will it be as sensitive to material that accumulates around the measuring device. These are important advantages over the known technology. In the direction perpendicular to the measuring surface, the body has such a high degree of rigidity that no changes will occur in the refining gap, which is another advantage.

Additional advantages and features of the invention are revealed in the sub-claims.

The present invention will now be described with reference to the embodiment illustrated in the accompanying drawings, in which

Figure 1	shows a view in perspective of a refining segment forming part of a refining disc, provided with measuring devices in accordance with the present invention;
Figure 2	shows a basic layout sketch of a measuring device in accordance with the present invention;
Figures 3a and 3b	illustrate the force ratio applicable for the invention; and
Figure 4	shows a view, partly in section, of a measuring device in accordance with the present invention.

Figure 1 thus illustrates a part of a refining disc in the form of a refining segment 1, provided with a pattern comprising a number of bars 3 extending in substantially radial direction. Measuring devices 5, in accordance with the present invention, are also illustrated schematically in this figure. These measuring devices preferably have a circular measuring surface, with a diameter in the order of magnitude of 30 mm, for instance, but the measuring surface may also have a different geometric shape. The measuring devices are preferably arranged at different radial distances from the centre of the refining disc, and segments at different distances from the centre are also preferably provided with measuring devices. It is also advantageous for the measuring devices to be staggered peripherally in relation to each other, all with the object of being able better to determine the force distribution in the refiner and thus better to control the refining process. When a measuring device is affected by a force parallel with the surface of the refining disc/segment, the force sensor of the measuring device will generate a signal that is proportional to the load.

The measuring device according to the invention functions in accordance with the principle illustrated in figure 2. A disc segment 1 can be seen here from

the side, equipped with bars 3. A measuring device 5 is also visible, comprising a part of the surface of the disc segment and being provided with a number of bars 6, or at least parts thereof. When the refining disc is subjected to a shear load F, the measuring device 5 (the sensor) will take up a load F_m which is denoted by the following expression:

$$F_m = F \cdot \frac{l_1}{l_2} \qquad (1)$$

where l_2 is the distance between the point where a sensor 10 in the measuring device is secured and the joint 8 of the device, and where l_1 is the distance between the measuring surface 7 of the measuring device and the joint 8. This formula is valid provided the joint does not take up any torque, and that the pressure distribution over the measuring surface 7 subjected to the shear force is not too uneven. The joint 8 consists in principle of a metal sheet of such small thickness as to give a negligible contribution to the total stiffness of the measuring device while at the same time being able to withstand the loads to which it is subjected. The thickness of the metal sheet can at the same time be rather large since the sensor itself is relatively rigid, giving little flexure in the sheet. The dimension of the joint 8 shall thus be adjusted to withstand the vertical load occurring, while at the same time absorbing only a negligible part of the lateral load that the screw and the sensor shall absorb. See also the detailed description in conjunction with figure 4.

The model in figures 3a and 3b describes how high and low rigidity, respectively, affect the function of the measuring device, through the rigidity that sensor, attachment screw (the attachment member by which the sensor is fixed in relation to the measuring surface and the body, see Fig. 4) and joint possess. The force and the torque absorbed by the sensor/attachment screw and the joint, respectively, are controlled by the ratio $F_{sensor} = k_2 \cdot \delta$ and $M = k_3 \cdot \Delta\varphi$, where M is the torque in the joint. k_2 is in this case the rigidity of the spring 15, that is to say the sensor 10 together with the attachment screw 20, and k_3 is the rigidity of the journalling point/joint 8. The ratio shows clearly that if F = constant and k_2 increases, then δ will decrease, and thus also M since the torque is directly proportional to the flexure δ for small angles. In the case under discussion k_2 is large and the equation (1) is therefore valid.

It should be pointed out that, in this case, relatively high rigidity of the sensor/attachment screw results in high rigidity in relation to the load that the sensor/screw shall absorb. The load may vary greatly across the refining zone, e.g. from an order of magnitude of 20N to an order of magnitude of 150N. In the present case, with an estimated average value of about 40N, displacements of the measuring surface are obtained that can be measured in hundredths of a millimetre. As mentioned earlier, these minor displacements facilitate sealing the device from the surrounding environment. As to the body 17, this can be considered as completely rigid in the direction perpendicular to the measuring surface.

Figure 4 shows a preferred embodiment of a measuring device in accordance with the present invention. The measuring device 5 comprises a measuring surface 7 provided with bars 6, or parts of bars, which measuring surface constitutes a part of a disc segment as illustrated in figure 1. As can also be seen in figure 1, the measuring device has a preferably circular measuring surface.

The measuring surface 7 is in direct contact with a body 17, preferably of steel, extending inside the device. The measuring surface is preferably screwed to the body 17. Slightly below the measuring surface the body 17 is provided with a transverse recess in which a force sensor 10 is arranged, preferably a quartz sensor. Here, too, the body 17 is provided with a through hole in which an attachment screw 20 is applied, passing through the hole and securing the sensor 10. The sensor 10 is thus fixed in relation to the body 17 by means of the screw 20, as will be described below. Other attachment means for the sensor 10 are naturally possible. Otherwise, the body 17 preferably has a circular cross section. Further down beneath the sensor, the body 17 assumes a narrowing, flattened shape in an area corresponding to the joint 8, mentioned earlier, and described in conjunction with figures 2, 3a and 3b.

The sensor 10 and the body 17 are arranged inside a protective casing 22. This casing has an opening at the top, adjacent to the surrounding refining segment, which is closed by the measuring surface 7, a seal 12 surrounding the measuring surface, and a sleeve 13 in which the seal is arranged. The seal 12 is of a particularly suitable, somewhat yielding material such as rubber, so that it can permit the small movements that the shear forces give rise to in the measuring surface, and still achieve a good seal that prevents steam and pulp from penetrating into the device. The seal preferably has a dampening effect as regards, inter alia, the vibrations that occur during operation. The purpose of the sleeve 13 is primarily to facilitate sealing of the measuring device since the measuring surface and the seal are first assembled in the sleeve which can then easily be inserted partially into the casing 22. Naturally, it is possible to omit the sleeve.

The casing 22 also has a function in securing the sensor 10 in relation to the measuring surface 7. The sensor is thus secured in the casing by means of the attachment screw 20. Finally, the body 17 is attached in the casing at the nd opposite to the measuring surface.

The invention is not limited to the embodiment illustrated in the drawings. It can be modified and altered in many ways obvious to one skilled in the art, within the scope of the appended claims.